REMARKS

Claims 5 and 9 are pending. By this Amendment, claim 5 is amended. Support for the amendments to claim 5 may be found, for example, in the claims as filed and in the instant specification at page 10, lines 1-10. No new matter is added.

In view of the foregoing amendments and following remarks, reconsideration and allowance are respectfully requested.

I. Rejections Under 35 U.S.C. §103

A. Engeler and Seki

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,558,375 to Engeler ("Engeler") in view of U.S. Patent No. 5,409,569 to Seki et al. ("Seki"). Applicant respectfully traverses the rejection.

By this amendment, claim 5 is directed to evaluating crystal defects of a silicon wafer by etching a surface of the silicon wafer by immersing the wafer in an etching solution and observing etch pits formed on the etched surface of the wafer, wherein the silicon wafer of which crystal defects are evaluated has low electrical resistivity of 1 Ω•cm or less, the etching solution used for etching the surface of the silicon wafer is a mixture of hydrofluoric acid, nitric acid, acetic acid and water in a ratio of 1 : 13-17 : 4-8 : 4-8 and the etching solution further includes iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter of total liquid volume of the etching solution to decrease the etching rate of the etching solution, and the etching solution is adjusted to have an etching rate of 100 nm/min or less for the silicon wafer.

Traditionally, it has been problematic to accurately evaluate crystal defects of a silicon wafer with low electrical resistivity, such as 1 Ω•cm or less. See specification, page 3, line 8 - page 4, line 17. Thus, the claimed invention was developed to address the above

problem and achieves accurate evaluation of crystal defects of a silicon wafer by utilizing each feature recited in claim 5.

The Office Action asserts that Engeler discloses a method of fabricating a semiconductor structure that comprises etching a surface of a silicon wafer by immersing the silicon wafer in an etching solution, the etching solution comprising 160 cc acetic acid, iodine, 280 cc nitric acid, and 50 cc HF, which the Office Action asserts reads on the etching solution being a mixture of hydrofluoric acid, nitric acid, acetic acid and water further including iodine or iodide, and wherein the volume ratio of nitric acid in the etching solution is the largest among the volume ratios of hydrofluoric acid, nitric acid, acetic acid and water. However, the Office Action acknowledges that Engeler fails to disclose the claimed ratio of hydrofluoric acid : nitric acid : acetic acid : water, and that the claimed removal amount of the surface of the silicon wafer is 50 nm or more. Therefore, the Office Action applies the disclosure of Seki to address the discrepancies of Engeler.

The Office Action asserts that Seki discloses, in a semiconductor manufacturing method, using an etching solution comprising HF, nitric acid, and acetic acid. The Office Action further asserts that the concentration of the acids vary, and that an iodine-containing etching solution requires nitric acid of higher concentration. The Office Action also asserts that Seki provides evidence that changing the concentration of the elements of the etching solution according to the materials being etched appears to reflect a result-effective variable and, thus, the Office Action asserts that it would have been obvious to one of ordinary skill in the art to have modified the concentration of the acids in the etching solution disclosed in Engeler to adjust the etching rate of the etching solution.

However, Applicant respectfully asserts that it would not have been obvious to one of ordinary skill in the art at the time of the invention to have combined the disclosures of Engeler and Seki to yield the claimed invention as suggested in the Office Action.

Engeler is directed to the fabrication of diodes comprising a step of etching and, thus, the disclosure of Engeler does not provide a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. Therefore, Engeler does not teach or suggest that an etching rate of an etching solution specifically used for fabricating diodes can or should be adjusted to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the silicon wafer with low electrical resistivity. Accordingly, Engeler does not provide any reason or rationale for one of ordinary skill in the art to have modified the etching solution disclosed therein to have the precisely claimed ratio of hydrofluoric acid : nitric acid : acetic acid : water and to also include iodine or iodide in the amounts as claimed at least because Engeler does not disclose, teach or suggest that the etching rate of an etching solution can or should be adjusted in order to accurately evaluate crystal defects of a silicon wafer with low electrical resistivity.

Further, Seki discloses an etching solution containing hydrofluoric acid and an oxoacid or oxoacid salt compound expressed by Mm(XOn)p (where M is hydrogen, one- to three-valence metal or NH_4, m is 1 or 5, X is a halogen element, n is 3, 4 or 6, and p is 1, 2 or 3). See Seki, col. 2, line 66 to col. 3, line 3. Seki further discloses that conventional etching solutions cause degeneration of a photoresist and deterioration in adhesion between a photoresist and a silicon to be treated and, consequently, fine patterns cannot be achieved with conventional etching solutions. See Seki, col. 2, lines 18-33. Furthermore, Seki discloses that acetic acid acts to damage the photoresist such that photoresist dissolved portions are produced to change the photoresist into a porous film, and that this also impedes the conventional etching solution from being applied to form fine patterns. Seki thus discloses that acetic acid should not be used in an etching solution. See Seki, col. 2, lines 34-41.

Thus, the etching solution in col. 6, lines 10-20 of Seki, which the Office Action asserts discloses that changing a concentration of HF and iodine in the etching solution will affect the etching rate of silicon, is an etching solution with only hydrofluoric acid and iodic acid as components. Therefore, Seki merely discloses that as the concentration of either hydrofluoric acid or iodic acid increases in an etching solution that contains only hydrofluoric and iodic acid, the etching rate will increase. However, Seki does not disclose, teach or suggest how a complex etching solution comprising hydrofluoric acid, nitric acid, acetic acid, water and iodine or iodide, such as the claimed etching solution, would be affected by increasing the concentration of the hydrofluoric acid, iodine or iodide components. Merely because a two-component etching solution, such as an etching solution made of hydrofluoric acid and iodic acid, is affected in a certain way by increasing the concentration of its components, is insufficient to provide any reason or rationale that a five-component etching solution, such as the claimed etching solution, would be affected in a similar manner.

Also, the etching solution of Seki does not utilize acetic acid, for the reasons stated above. However, when the volume ratio of acetic acid and water in the etching solution is increased, the etching rate is decreased considerably. See specification, page 18, lines 18-24. Therefore, while Seki may disclose that increasing the concentration of either component of a two-component etching solution will increase the etching rate, Seki does not provide any reason or rationale for one of ordinary skill in the art to have known that increasing the amount of acetic acid in a etching solution would decrease the etching rate of a five-component etching solution.

Additionally, Seki discloses etching solutions and a method for etching a silicon semiconductor material using the etching solutions, but Seki does not disclose, teach or suggest a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. Thus, Seki does not teach or suggest that an etching rate of an etching solution

can or should be modified to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer. Therefore, as was the case with Engeler, Seki provides no reason or rationale for one of ordinary skill in the art to have adjusted the components of an etching solution so that the etching rate of the etching solution would be within a range where one could accurately evaluate crystal defects of a silicon wafer with low electrical resistivity. Put differently, neither Engeler nor Seki, individually or in combination, teach or suggest that the etching rate of an etching solution can or should be optimized in order to evaluate crystal defects of the silicon wafer with low electrical resistivity and, thus, neither Engeler nor Seki, individually or in combination, provide any reason or rationale for one of ordinary skill in the art to have modified the etching solution disclosed in Engeler to the etching solution as claimed.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Engeler and Seki, individually or in combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Engeler and Seki, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

B. Tiemann and Seki

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,772,102 to Tiemann et al. ("Tiemann") in view of Seki. Applicant respectfully traverses the rejection.

Features of claim 5 are recited above. The Office Action asserts that Tiemann discloses a method for transferring a desired pattern in a silicon to a substrate layer comprising etching a surface of the silicon wafer by immersing the wafer in an etching solution, where the etching solution comprises 3 parts acetic acid, iodine, 5 parts nitric acid and 3 parts HF, which the Office Action asserts reads on the etching solution being a mixture

of hydrofluoric acid, nitric acid, acetic acid and water further including iodine or iodide. However, the Office Action acknowledges that Tiemann fails to disclose hydrofluoric acid : nitric acid : acetic acid : water in the volume ratio as claimed, and that the claimed removal amount of the surface of the silicon wafer is 50 nm or more. Therefore, the Office Action applies the disclosure of Seki to address the discrepancies of Tiemann in the same manner that Seki was applied in the combination of Engeler and Seki.

However, as was the case with Engeler, Tiemann does not disclose a method for evaluating crystal defects of a silicon wafer with low electrical resistivity and, thus, Tiemann does not teach or suggest that the etching rate of an etching solution can or should be modified to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer. Thus, Tiemann provides no reason or rationale for one of ordinary skill in the art to have adjusted the volume ratio of an etching solution comprising hydrofluoric acid, nitric acid, acetic acid, and water in the ratio as claimed and further comprising iodine or iodide in the claimed amount to provide an etching solution with an etching rate as claimed.

Additionally, for at least the reasons stated above, Seki fails to teach or suggest that the etching rate of an etching solution comprising hydrofluoric acid, nitric acid, acetic acid, water and iodine or iodide can be decreased by adjusting the concentration of the components. Further, Seki fails to teach or suggest that an etching rate of an etching solution can or should be adjusted in order to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer. Thus, neither Tiemann nor Seki, individually or in combination, provide any reason or rationale for one of ordinary skill in the art to have adjusted the concentration of the components and the etching rate of the Tiemann etching solution to be within the claimed range because neither Tiemann nor Seki, individually or in combination, teach or suggest that the etching rate can or should be adjusted

to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Tiemann and Seki, individually or in combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Tiemann and Seki, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

C. **Gantley and Seki**

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,960,623 to Gantley ("Gantley") in view of Seki. Applicant respectfully traverses the rejection.

Features of claim 5 are recited above. The Office Action asserts that Gantley discloses a semiconductor etching method comprising etching a surface of a silicon wafer by immersing the wafer in an etching solution, the etching solution comprising acetic acid, iodine, nitric acid and HF, which the Office Action asserts reads on the etching solution being a mixture of hydrofluoric acid, nitric acid, acetic acid and water further including iodine or iodide. However, the Office Action acknowledges that Gantley fails to disclose the claimed ratio of hydrofluoric acid : nitric acid : acetic acid : water and that the claimed removal amount of the surface of the silicon wafer by etching is 50 nm or more. Therefore, the Office Action applies the disclosure of Seki, in the same manner as in the rejection over Engeler and Seki as well as the rejection over Tiemann and Seki, to address the discrepancies of Gantley as to claim 5.

Gantley discloses a method for selectively masking bodies of semiconductor material and, thus, does not disclose a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. See Gantley, col. 1, lines 46-55. Thus, Gantley does not teach or

suggest that an etching rate of an etching solution can or should be adjusted to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer.

Additionally, for at least the reasons stated above, Seki fails to teach or suggest that the etching rate of an etching solution comprising hydrofluoric acid, nitric acid, acetic acid, water and iodine or iodide can be decreased by adjusting the concentration of the components. Further, Seki fails to teach or suggest that an etching rate of an etching solution can or should be adjusted in order to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer. Thus, neither Gantley nor Seki, individually or in combination, provide any reason or rationale for one of ordinary skill in the art to have adjusted the concentration of the components and the etching rate of the Gantley etching solution to be within the claimed range because neither Gantley nor Seki, individually or in combination, teach or suggest that the etching rate can or should be adjusted to accurately evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Gantley and Seki, individually or in combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Gantley and Seki, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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WPB:NAB/mkg

Attachments:
Request for Continued Examination
Petition for Extension of Time

Date: February 11, 2009

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